QUALITY MANAGEMENT PLAN

FOR THE

DEPARTMENT OF ENVIRONMENTAL QUALITY

DIVISION OF WATER PERMITTING
DIVISON OF WATER PLANNING

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629 East Main Street
P.O. Box 1105
Richmond, VA 23219

QUALITY ASSURANCE MANAGEMENT PLAN IDENTIFICATION FORM

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Organization Title:	Department of Environmental Quality
Address:	629 East Main Street Richmond, VA 23219
Responsible Official:	David Paylor
Title:	Director, Virginia Department of Environmental Quality
Quality Assurance Coordinator:	James Beckley
Phone:	(804) 698-4025
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QUALITY ASSURANCE MANAGEMENT PLAN APPROVALS

(1) Name: James Beckley
Title: Quality Assurance Coordinator - VADEQ

Signature: _____ Date: _____

(2) Name: John Kennedy
Title: Manager, Office of Ecology - VADEQ

Signature: _____ Date: _____

(3) Name: Elizabeth Mckercher
Title: Manager, Office of Watershed Programs - VADEQ

Signature: _____ Date: _____

(4) Name: Jerome Brooks
Title: Manager, Office of Water Compliance - VADEQ

Signature: _____ Date: _____

(5) Name: David Davis
Title: Manager, Office of Wetlands and Stream Protection – VADEQ

Signature: _____ Date: _____

(6) Name: Andrew Hammond
Title: Manager, Office of Stormwater Management - VADEQ

Signature: _____ Date: _____

(7) Name: Scott Kudlas
Title: Manager, Office of Water Supply – VADEQ

Signature: _____ Date: _____

(8) Name: Neil Zahradka
Title: Manager, Office of Land Application Programs – VADEQ

Signature: _____ Date: _____

(9) Name: Fred Cunningham
Title: Manager, Water Permitting – VADEQ

Signature: _____ Date: _____

(10) Name: Jutta Schneider
Title: Director, Division of Water Planning - VADEQ

Signature: _____ Date: _____

(11) Name: Melanie Davenport
Title: Director, Division of Water Permitting – VADEQ

Signature: _____ Date: _____

(12) Name: Terry Simpson
Title: Region 3 Quality Assurance Manager – USEPA

Signature: _____ Date: _____

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List of Key Acronyms

CEDS	Comprehensive Environmental Data System
DCLS	Division of Consolidated Laboratory Services
DQA	Data Quality Assessment
DQO	Data Quality Objective
LCS	Laboratory Control Sample
LCSD	Laboratory Control Sample Duplicate
NELAC	National Environmental Laboratory Accreditation Conference
MS	Matrix Spike
MSD	Matrix Spike Duplicate
OIS	Office of Information Services
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
QMP	Quality Management Plan
RPD	Relative Percent Difference
SOP	Standard Operating Procedure
TSA	Technical System Audit
USEPA	United States Environmental Protection Agency
WD	Water Permitting and Water Planning Divisions,
VADEQ	Virginia Department of Environmental Quality

1.0 Management and Organization

1.1 Introduction

The Commonwealth of Virginia Department of Environmental Quality (VADEQ) is mandated by the State Water Control Law (Chapter 3.1 Title 62.1 of Code of Virginia section §62.1-44.2) to protect existing high quality state waters and to provide for the restoration of all other state waters. In accordance with this mandate, the VADEQ established procedures for investigating, monitoring, restoring, and scientifically evaluating water quality and water problems. The management and staff of the VADEQ are committed to producing environmental data and technology consistent with the guidelines presented in the Quality Management Plan (QMP). Adherence to quality system requirements assures that environmental data and technology are suitable for the technical decision making process, protection of the environment, and management of the VADEQ mission.

The purpose of this QMP is to document management policies, goals, objectives and general procedures by which the VADEQ produces and validates acceptable data. Implementation of this plan within the various field and laboratory water quality program efforts ensures that decisions made by the agency affecting the Commonwealth's water quality are based upon sound professional principles and environmental data of known and acceptable quality.

This QMP defines and describes the quality assurance and quality control policies and responsibilities prescribed by the Division of Water Permitting and Division of Water Planning (WD) in accordance with USEPA Order 5360.1 "Policy and Program Requirement to Implement the Mandatory Quality Assurance Program," USEPA QA/R-1 "EPA Quality Assurance Requirements for Quality Management Programs," and USEPA QA/R-2 "EPA Requirements for Quality Management Plans." This document links the management policies, objectives and principles of the program with the procedures described in associated Quality Assurance Project Plans (QAPPs) and Standard Operating Procedures (SOPs), which are designed to produce data of known quality. These policies should guide the Project Manager in the uniform implementation of QA/QC requirements for all monitoring programs.

This QMP covers the collection and analysis of water quality samples along with associated metadata used by the VADEQ offices outlined in Figure 1.

1.2 Goals

The goals of the VADEQ's Water Divisions QA systems are:

(a) To ensure that all environmental data generated by or for the agency that will be utilized to determine water quality or watershed restoration progress is scientifically valid, defensible, and of documented and adequate quality.

(b) To ensure that all water quality monitoring activities performed by or under contract for the VADEQ have approved QAPPs prior to the start of collection activities.

(c) To maintain communication on QA issues and activities among management and staff.

(d) To perform assessments to determine the effectiveness of the QA system. Continued improvement in the quality management system is emphasized.

(e) To accomplish QA processes in the most cost-effective manner without compromising data quality.

1.3 Policy

It is the intent of the VADEQ WD to implement the following QA policy:

a) To ensure data generators produce quality data by providing easy access to all necessary documentation and QA training and oversight.

b) Where applicable, ensure staff and external organizations generating data follow the requirements outlined in this QMP, subsequent policy, and standard operating procedures.

c) To require a QAPP that describes intended data use, specific quality assurance activities, level of quality to be obtained, and data acceptance criteria for field, laboratory, and data management activities. These plans must be approved prior to and implemented upon initiation of the water quality monitoring program for which they are intended.

d) To ensure sufficient resources are allocated to guarantee that QA activities provide the desired level of data quality.

e) To conduct regular periodic or, where required, annual Technical System Audits (TSA) on monitoring staff and laboratory personnel and contractors to ensure that they comply with quality management system requirements and to address any highlighted deficiencies in a timely manner.

1.4 Quality Assurance Management

The VADEQ recognizes the importance of QA to all aspects of its program and activities. QA is an integral part of the agency management plan and receives strong management support.

A Quality Assurance Coordinator is assigned accountability for the management of the WD QA program. The Quality Assurance Coordinator is provided with resources to help develop and implement associated program activities and work with Program Quality Assurance Officers where necessary.

1.5 Assignment of Responsibilities

The VADEQ WD and the Division of Consolidated Laboratory Services (DCLS) are responsible for their respective sampling, analytical, and data management programs. The organizational

and management responsibilities, responsible individuals, and organizational structures for these agencies are provided in Figures 1 and 2.

1.5.1 VADEQ Roles and Responsibilities:

Division Directors:

The Directors have overall responsibility for managing the QA program within the agency regarding offices under their oversight in accordance with the VADEQ QMP. Each Director has the authority to ensure that adequate resources are provided to support necessary QA program responsibilities.

Program Managers:

The Program Managers coordinate staff to ensure implementation of the quality management system where environmental measurements are to occur.

Regional Office Program Managers:

a) Implement and oversee the WD QA policies within regional offices.

b) Disseminate QA information within regional offices.

c) Assist in the development of QA policies and procedures.

d) Assist in solving QA related problems

Quality Assurance Coordinator:

a) Provides general management of the VADEQ WD QA programs.

b) Identifies and responds to QA and QC needs, resolves problems, and answers requests for guidance and assistance.

c) Provides assistance to the VADEQ staff and external data generators in QA-related matters (i.e. study design or method selection).

d) Develops or assists in the development of major program area project plans.

e) Provides guidance and assistance to Project Managers and external data generators in the development and implementation of specific QAPPs.

f) Reviews and approves all internally and externally generated water quality related QAPPs where the VADEQ is obtaining data.

g) Identifies program specific QA related training needs.

h) Provides and obtains technical assistance from USEPA QA personnel.

i) Reviews external project proposals to determine the need for a QAPP.

j) Provides independent reviews of all programs and contractual QA/QC practices while maintaining open communication with program and contractual personnel.

k) Performs duties of Program Quality Assurance Officer if necessary.

Program Quality Assurance Officer:

a) Performs QA system audits – systematic qualitative review of facilities, equipment, training, procedures, record keeping, data validation, data management, and the reporting aspects of the total QA system. The audits are designed to insure that the QA program and QAPPs contain approved sample handling and analytical procedures and that those procedures are in use.

b) Conducts QA performance audits – quantitative analyses or checks, such as using reference samples to determine the accuracy of a measurement system.

c) Review analytical data and support the collection of QA data to ensure that only data of known quality and integrity are available for entry into the database.

d) Review and approve program specific QAPPs

1.5.2 Contract Project Manager Responsibilities:

a) QAPP development, implementation, evaluation, and reporting to DEQ.

b) Identify and report QA problems and needs to the VADEQ QA Coordinator or Program QA Officer as they occur.

1.5.3 Organizational Responsibilities:

The VADEQ WD has overall management responsibility including:

a) Program design

b) Sample collection, preservation and handling

c) Field analysis

d) Field quality control

e) Data interpretation

f) Record keeping and reporting (shared responsibility)

g) Data entry, validation, and reduction (shared responsibility)

DCLS has the overall responsibility for sample analysis including:

a) Laboratory related quality assurance program and project plans

b) Sample analysis

c) Method evaluation and selection

d) Determination of accuracy and precision

e) Participation in USEPA and/or NELAC system and performance audits

f) Record keeping and reporting (shared responsibility)

g) Data entry, validation and reduction (shared responsibility)

1.6 Communications

The Program QA Officers shall notify the Program Managers of any identified problem areas. Corrective action will be taken as needed. A follow-up review of the corrective action will be made by the Program QA Officer and the Program Managers to verify that problems have been resolved.

Formal lines of communication regarding the QA program status and needs are essential to ensure that an effective QA program is implemented within the VADEQ. The Quality Assurance Coordinator or designee will have direct access to the VADEQ and DCLS management on QA matters. The VADEQ will also provide appropriate training on an on-going basis in order to ensure that the VADEQ personnel responsible for QA functions understand the QA requirements and practices related to their responsibilities.

Figure 1 VADEQ Monitoring, Planning, & Permitting Activities Organizational Chart -2015

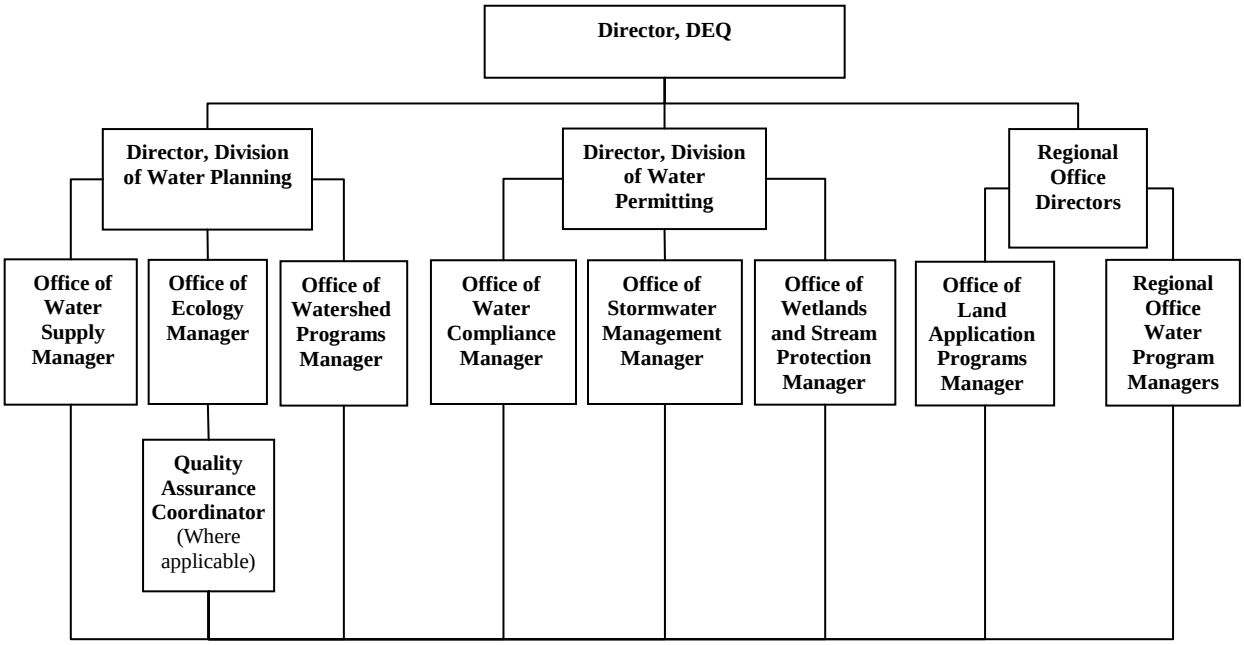
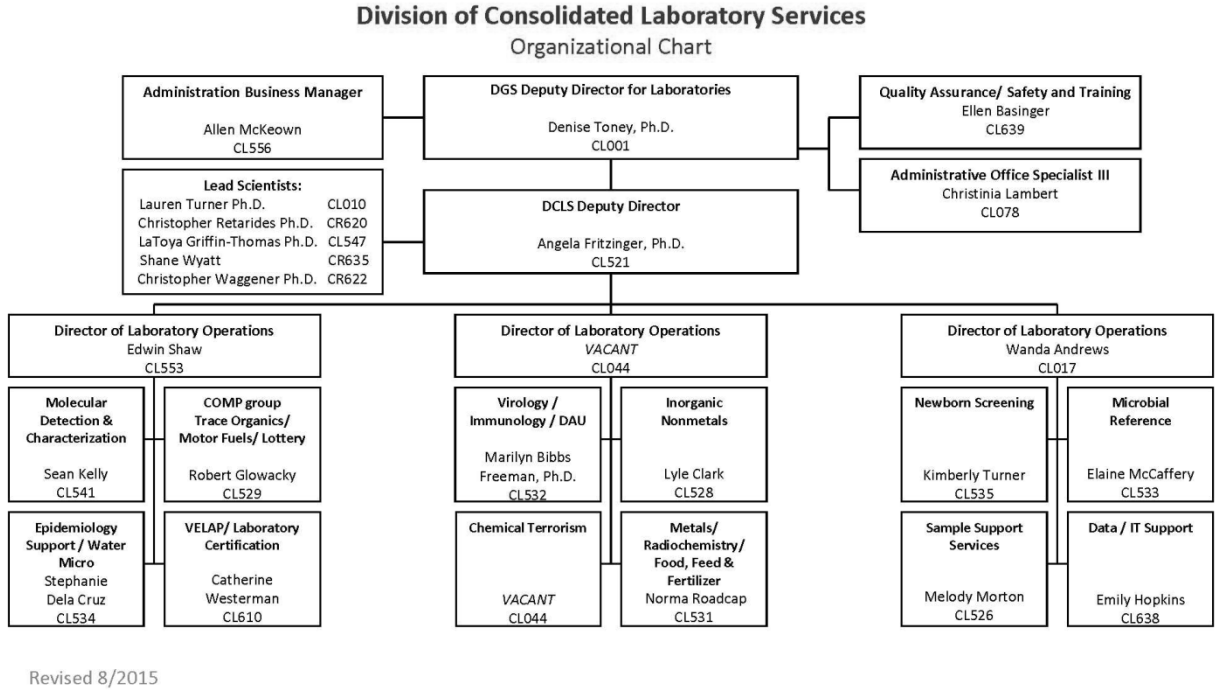


Figure 2 DCLS Organization Chart -2015



2.0 QUALITY SYSTEM COMPONENTS

The VADEQ WD requires the following:

a) Each special study project generating environmental data will develop and implement a QAPP that addresses the required major elements and ensures that adequate resources (both monetary and staff) are provided to support the QA effort. The QAPP will specify the detailed procedures required to assure quality data. The Program QA Officers must approve QAPPs prior to data collection.

b) All environmental and related water quality data generated will be of known and acceptable quality as defined in the data quality objectives. The data quality information developed with all environmental data will be documented and available.

c) All USEPA and state funded environmental data collection efforts will ensure that acceptable QA requirements are included and implemented.

d) The intended use of the data is defined before the data collection effort begins so that appropriate QA measures may be applied to ensure a level of data quality commensurate with the monitoring objectives. The determination of this level of data quality shall also consider the prospective data needs of secondary users. Data quality objectives are established to ensure the utility of monitoring data meets its intended uses and to serve as guidance for preparation of QAPPs. The intended data uses, level of quality, specific QA activities, and data acceptance criteria needed to meet the data quality needs of these uses are described in each monitoring activity's QAPP.

e) The QA activities are designed in the most cost-effective fashion possible without compromising data quality objectives.

2.1 Principal components and tools of the quality management system

The primary QA planning and implementation components include a QMP, establishment of data quality objectives, QAPP, SOP, and QA status reports. The components are listed below. Section 8 of this document discusses in detail staff responsibilities for the development of each component. Section 9 of this document covers the tools required for their implementation.

2.1.1 Quality Management Plan

The VADEQ WD QMP describes policies, procedures, and systems governing program specific data collection activities. It serves as the general document for QA operations. The QMP will be reviewed annually and revised as necessary.

2.1.2 Data Quality Objectives

Data Quality Objectives (DQOs) are statements of the quality of environmental data required to support program decisions or actions. DQOs establish the level of risk or uncertainty that a

program is willing to accept in the environmental data in order to make a defensible decision. The VADEQ Quality Assurance Officer refers to USEPA QA/G-4 *Guidance for the Data Quality Objectives* when developing DQOs and submits them to appropriate management for review and approval. DQOs are updated as needed to reflect changes in environmental policies as defined by management. DQOs are intended to accomplish the following: 1) clarify the project objectives, 2) define the most appropriate types of data to collect, 3) determine the most appropriate conditions under which to collect the data, and 4) specify the level of uncertainty that is acceptable as the basis for establishing the quantity and quality of data needed.

2.1.3 Quality Assurance Project Plans

Effective management of a data collection program requires periodic assessment of the quality of the data being obtained to establish a basis to determine when and if corrective action may be needed. To ensure that this assessment occurs, all environmental monitoring and data collection planned or conducted through the WD shall have an associated QAPP.

The QAPP shall ensure that:

a) The level of data quality needed is determined and stated prior to data collection;
b) All environmental data generated and processed will reflect the quality and integrity established by the QAPP.

The Program QA Officers shall notify the Project Managers immediately of any problem areas identified. The QA Officers will jointly outline necessary changes and Project Managers will institute the corrective actions. The Program QA Officers will conduct a follow-up review of the required changes. Project Managers will verify that the identified problems have been corrected.

The project plan is used as a guidance document for Contract Project Managers, who are responsible for the development of QAPPs for all special studies, investigations, and intensive surveys conducted by the VADEQ. Any project plans that are developed externally or internally will follow the USEPA QA/R5 *Requirements for Quality Assurance Project Plans for Environmental Data Operations* guidance document and submit them to the Program QA Officers for approval prior to initiation of data collection activities. The Office of Ecology has developed an example template that follows the EPA QA/R5 format to aid staff and external organizations in the project plan development and review process.

The Program QA Officers review and approve submitted QAPPs in the context of the program's DQOs. Reviews shall follow the QAPP review checklist listed in the EPA QA/R-5 guidance document.

Program Managers will update project plans for special studies as needed and resubmit the plans to the Program QA Officers for review and approval. The Program QA Officers will review project plans annually and update the documents as necessary. Updates will be reviewed by designated staff and managers and approved by the Program Managers.

2.1.4 Standard Operating Procedures

The use of Standard Operating Procedures (SOPs) serves as a mechanism to ensure comparability across environmental data collection projects of various programs. A project's SOP may be either standalone document or may be incorporated into the project QAPP. In either case, the SOP is maintained by Program QA Officers.

SOPs detail the work processes conducted or followed within the program. The SOP documents the way activities are to be performed to facilitate consistent conformance to technical and quality system requirements and to support data quality. The SOP is intended to be specific to the program whose activities are described and assist the program in maintaining its QA/QC processes.

The best written SOPs will fail if not followed. Therefore, the use of SOPs needs to be reviewed and reinforced by appropriate QA Officers and Program Managers Current copies of SOPs also need to be readily accessible for reference in the work area of those individuals actually performing the activity, either in hard copy or electronic format. To ensure availability, SOPs are available on an internal webpage designed to provide all the necessary documents required by the VADEQ staff to conduct their daily operations.

SOPs need to remain current. Whenever field procedures or analytical requirements are changed, the SOPs should be updated, reviewed, and re-approved as soon as possible rather than waiting for an annual review. Changes or modifications may be exclusively made to the pertinent section of a SOP, but the process must indicate the modification date and/or revision number in the document control notation.

It is the responsibility of the Program QA Officers to ensure that policies and procedures are current and that any changes are communicated to the program staff to implement in their environmental data operations. SOPs undergo review on at least an annual basis to ensure that any procedures not yet updated to reflect changes in field procedures or analytical requirements are brought up to date.

2.1.5 Quality Assurance (QA) Status Reports

Where necessary, A QAPP will include information on the frequency, content, and format of the required QA status reports. The Quality Assurance Coordinator or Program QA Officers submit status reports to help track QA progress to the applicable Program Managers. Generally, such reports are produced quarterly and will address the following elements:

1) Changes that occurred in program activities (sampling, QC control measures, analytical methods).
2) A summary of performance and system audits, as they apply.
3) Any corrective actions taken.
4) Any organizational changes.
5) Reports of the assessment of data quality indicators (precision, accuracy, completeness, representativeness, and comparability).

3.0 PERSONNEL QUALIFICATION AND TRAINING

3.1 Training Policy

All VADEQ personnel associated with water quality data generation or data management activities and DCLS personnel who generate water quality data must have adequate knowledge and skills in their technical specialties and applicable QA practices to ensure quality data is generated.

The VADEQ has developed, implemented, and continually refines a program of internal training to ensure staff have the appropriate knowledge and skillset to perform their assigned responsibilities.

In situations where the VADEQ is the appropriate authority, data collection partners will receive training under VADEQ oversight to ensure accepted procedures are followed.

3.2 Training Qualifications and Documentation

Entry level training is provided for new employees to ensure they are qualified for their assigned position. Generally, this involves field methods (such as instrument operation, approved sample collection, preservation, handling, field testing, and QA procedures) and/or in computer skills (such as station establishment, sample scheduling, and data entry and retrieval). Training in field methods is provided by the Quality Assurance Coordinator or by a designee and experienced regional personnel. A team of qualified personnel provides training in computer skills. All training documentation is retained by the Office of Training Services.

In addition, the VADEQ requires applicable staff to undergo periodic training and recertification of procedures found in the project-relevant SOP or QAPP. As an example, field monitoring positions require new hires to successfully complete the training modules before they collect chain of custody samples and no later than 12 months after their date of hire. After successful completion of the initial SOP training, field personnel are required to pass a retest, and take a refresher class if needed, every two years thereafter. Any existing staff that does not successfully complete the training must discontinue collecting water quality samples and be retrained and retested until they can successfully complete the testing.

Staff members who fail training or recertification, procedures to remedy the deficiency are outlined in the project-relevant SOP or QAPP. Generally the remedy applied is if staff do not successfully complete training or recertification, they are paired with an experienced mentor until they can successfully complete the testing. The training course can consist of a combination of techniques including video, webinars, online courses, and hands-on practice. The course content includes training on all aspects of the relevant SOP as well as the use of the associated data management programs such as the agency's Comprehensive Environmental Data System (CEDS).

3.3 Continued Proficiency

To ensure continued proficiency in QA/QC procedures, an audit of relevant staff is conducted by the agency QA Coordinator, Project QA Officer, or designee qualified to perform audit tasks. Due to the number of staff and regions involved and project needs, a QA audit of staff usually occurs about once every two years. Audits usually consist of reviewing the procedures used by the staff to see if they follow procedures written in the relevant SOP or guidance document. Evaluation and certification can also be accomplished through online assessment. Program specifics may vary but such assessment is usually done every two years.

3.4 Laboratory Personnel Training

Laboratories are independent organizations and not under VADEQ management. Specific procedures may vary but generally follow those adopted by DCLS as DCLS oversees the VELAP program.

A written position description for each job in the laboratory is kept on record within the laboratory division. The position descriptions include the knowledge, skills, abilities, and duties required of the position. A performance plan is prepared annually for each employee, and their performance is evaluated via one interim and one final evaluation. Training is conducted at the division and group level. Performance evaluation samples are routinely used to determine proficiency in an area. It is the responsibility of the group manager to ensure orientation and rotation of workstation schedules. The division maintains a training record documenting each employee's credentials regarding education, seminars, workshops, and on-site training. In order to assure competency and the ability to work independently, each employee is required to demonstrate completion of the following requirements:

1) Instruction in or prior knowledge of sample preparation, analysis, and instrumentation principals associated with the method.

2) Instruction on the principles of laboratory safety associated with the method, including review of associated MSDS forms.

3) Has read and understands the methods and SOPs associated with the analyses.

4) Instruction in or has prior knowledge of the instrument for the method.

5) Demonstrated performance of the method under the direct supervision of the trainer.

6) Instruction in or has prior knowledge of instrument and computer maintenance.

7) Independent successful completion of demonstration of capability.

8) Independent analysis of three sets of samples.

4.0 PROCUREMENT OF ITEMS AND SERVICES

4.1 Quality System Requirement for Items:

Conducting sufficient planning activities ensures purchased items meet predefined standards and specifications for quality. Technical staff directly involved in the use of the items will decide if items meet the necessary standards required to generate quality data unless a specific quality standard is specified in a regulatory document such as an analytical method. Standards and specifications, if not predefined, are developed in the planning process and included in the Program QAPP. Upon receipt of purchased items, the monitoring staff inspects each item for adherence to the specifications required by the Program QAPP. Specific guidance is available in the program SOPs. The Program QA Officer monitors and summarizes QC data and relays information regarding the effectiveness of the item to provide data consistency and exclude external contamination to Program Managers. Data summaries are provided to the Program Managers for review.

4.2 Quality System Requirements for Services

Designated VADEQ personnel conduct all services related to water quality monitoring activities in-house. In addition, VADEQ personnel evaluate any water quality data and associated information submitted by non-DEQ organizations, through several means. The most common evaluation process is through a tiered system in which the protocols used to generate the data or information is compared to methods used or approved by VADEQ personnel. Data meeting all DEQ sampling and QA protocols is treated at the highest quality and has the greatest use by the agency. Data failing to meet all requirements is used in more limited ways depending on the quality and type of information provided. Other forms of evaluation that differ from the above stated regimen are outlined in the applicable QAPP and SOP manual.

5.0 DOCUMENTS AND RECORDS

5.1 Identification of quality-related documents and Records

Quality-related documents and records consist of this QMP, project specific QAPPs and SOPs, and in the regional offices, field data or log sheets and calibration/maintenance logbooks. All monitoring and applicable VADEQ staff has access to these documents and records.

Organized and well-maintained files are critical to the proper functioning of programs within the WD.

5.2 Maintenance of Records

Each Program QA Officer is responsible to ensure the program's QMP, QAPP, SOP, and other specific quality practices are stored in the Oracle database or on the VADEQ's intranet and are made available to outside interested parties. Specific procedures to maintain records are outlined in relevant program SOP or QAPP documents. For example, since the VADEQ water quality monitoring activities involve a significant amount of paper and electronic records, each regional office Program Manager is responsible for developing a master document log in order to maintain a comprehensive and current inventory of the program related field records. Laboratory QA Officers are responsible for the maintenance of laboratory QA documents as specified in their SOP or Project Plan.

All the documents and records are archived in a safe and secure place and special care is taken to preserve the integrity of documents. Currently, the regional offices enter field data into the VADEQ's central database, CEDS, where the data is secure and retrievable. Regional offices keep all hardcopies of field data sheets, calibration and equipment maintenance log sheets on file for seven years after which the regions dispose of the records.

Plans are underway to modify the Oracle database to capture instrument calibration and maintenance. Hardcopies of calibration and maintenance logs are currently kept indefinitely. Once the database modification is complete, the regions will have the option to dispose of hardcopies of calibration and instrument maintenance logs older than seven years.

The QA Coordinator and Project QA Officers review the project QAPPs on an annual basis and SOPs when necessary. Revisions to remove obsolete practices and include new field techniques are made as needed and reviewed by a committee consisting of appropriate VADEQ staff and, when necessary, project development partners. Final approval of the QC documents is the responsibility of the applicable WD Director. Each updated or new QA document is clearly identified with revision date and version identification. The approved document is issued to all applicable Program Managers for distribution to appropriate staff. Working copies of outdated or obsolete versions are disposed and replaced with the updated version. To ensure documentation of historical water quality monitoring practices, a copy of all documents are stored and available to VADEQ personnel via the CEDS database.

The majority of routine water quality samples are not collected for legal purposes that require formal chain of custody procedures. However, all water quality samples must meet specific criteria as outlined in the DCLS QAPP in order to be analyzed. DCLS sample and record management personnel reject samples that do not meet those criteria. Samples requiring specific chain of custody follow procedures outlined in the applicable SOP manual.

6.0 COMPUTER HARDWARE AND SOFTWARE

The exchange of data between the VADEQ regional and central offices, DCLS and other laboratories, data submitting organizations,and EPA is vital to many of the VADEQ's missions. The VADEQ utilizes CEDS to store all the data generated by the agency. The CEDS database was designed to have a unique module for each environmental media monitored by the agency. Teams were selected from each media to work with developers to ensure their module was designed to meet core business needs. CEDS is on an Oracle base dual client server system that allows complete backup of the system at all times and seamless transition from one server to the other in case one system fails. The Oracle database is compatible with the DCLS Laboratory Identification Management System (LIMS) and EPA STORET, enabling better connectivity with those entities.

Other databases are utilized depending on specific project criteria and in situations when the data is not appropriate to include in CEDS, such as information provided by non-VADEQ organizations that may not follow accepted DEQ protocols. Most of these other systems maintained by the VADEQ use an Oracle database structure to simplify administration and maintenance needs. However, some systems, such as those that are linked with Federal agencies, may use different software. In such cases, these systems are evaluated by the Office of Information Services (OIS) to ensure sufficient support is available to maintain affiliated programs and equipment.

OIS is responsible for managing the VADEQ's technology infrastructure and components. All information management system development, improvements, and updates are submitted to a Business Technology Group which consists of VADEQ personnel representing each media who generate data and utilize CEDS. Tasks are prioritized and given to OIS for implementation. Prior to implementing changes in the production database, they are thoroughly tested by groups selected from the respective media to ensure changes perform as expected and meet user requirements.

To ensure compatibility with existing programs, OIS staff review and install all software and hardware purchases within the agency.

The VADEQ's data standards and regulations vary within water quality monitoring programs, some of which receive funding from federal grants. Every water quality monitoring program is required to have a QAPP specifying their specific standards and regulations.

7.0 PLANNING

7.1 Planning Goals and Objectives

The largest component of data generated by the WD falls under the VADEQ Water Quality Monitoring Strategy. As outlined in the 2013 Virginia Water Quality Monitoring Strategy, the goal of the strategy is to "provide representative data that will permit the evaluation, restoration and protection of the quality of the Commonwealth's waters at a level consistent with such multiple uses as prescribed by Federal and State laws." The planning objective is to ensure sufficient quantities of quality data are collected to support the use of the data. The planning process is intended to document all activities related to the generation, analysis, and use of data.

For other WD projects, specific goals and objectives can and will vary. However, planning is performed with project partners and usually involves consulting with topic specific experts such as the QA Coordinator, database managers, consultant firms, and others. Project goals and objectives are outlined and documented before work begins to ensure the project is compliant with the stated goals and objectives.

7.2 Identification of Data Users and Suppliers

The VADEQ accumulated water quality and related datasets have multiple data users that include: environmental assessment planners and managers, EPA, regulated facilities, and other external groups. Data suppliers include sampling groups (such as citizen monitoring groups), environmental agencies, and contract laboratories as well as other external data generators.

7.3 Scheduling and Resources

For water quality monitoring related activities, each regional office submits annual monitoring plans based on the VADEQ's water quality monitoring strategy. The current monitoring strategy, revised in 2013, will undergo scheduled reviews in the future and be further revised as needed. Each region is responsible for identifying the available resources and ensuring those resources are utilized in the most efficient manner to meet project goals.

For other water related activities, such as water compliance and best management practice inventories, information is compiled on an ongoing and regular basis with help of the regional offices and external data partners. Specifics are outlined in the appropriate QAPP or guidance document.

7.4 Performance Criteria

Data obtained from the VADEQ programs is assessed, verified and qualified according to its intended use. Criteria or measures should include:

1) The objective for measurement data in terms of precision, accuracy, completeness, comparability, and representativeness;

2) Data quality assessments;

3) Validation/verification of results; and

4) Documentation establishing the requirements for those objectives.

7.5 QA/QC activities

The program planning process specifies which QA/QC activities are necessary to assess the quality performance criteria (e.g. QC samples for the field and laboratory, audits, technical assessments, and performance evaluations etc.). Key variables that determine or directly affect the quality of results are identified and controlled according to the specifications determined during the planning or design process.

7.6 External Data

The VADEQ must also coordinate the collection and use of environmentally related data across numerous government agencies, contractors, academic and private organizations, and trained volunteers. Close coordination and planning is essential to ensure that the data are of sufficient quality to support the intended use. The VADEQ encourages data sharing whenever possible, providing adequate data quality indicators are available so that quality of data is sufficiently known to support the applicable decisions.

7.7 Analysis, Evaluation and Assessment of Data

The program specific QAPP serves as the basis for the analysis, evaluation, assessment against the intended use, and quality performance criteria of acquired data. Data not meeting the criteria as specified in the project plan are flagged in the relevant database.

7.8 QAPP review, approval, and revision procedure

Any project (including special studies) involving the collection of environmental samples by VADEQ personnel or external organizations, is required to have an approved QAPP prior to collection and analysis of any samples. QAPPs are reviewed and approved by the Program QA Officer or QA Coordinator. Program QAPPs are reviewed at least annually, updated if needed, and revised copies are circulated within 30 days of significant changes.

8.0 IMPLEMENTATION OF WORK PROCESSES

8.1 Operating Policies and Procedures

The VADEQ has developed and uses the appropriate policy and procedures as needed for its programs. The QAPP and SOP for water quality monitoring are documented in writing and are accessible to all persons involved in the implementation of the program. DCLS has also developed its analytical method manual.

When the program uses data generated by external entitles, the external data undergoes the same evaluation and documentation procedure that the VADEQ generated program data would undergo before it is used by WD Offices. This ensures that data fit within the margins of error constraints as established by the VADEQ Program Managers. Data that do not meet the criteria are utilized to a lesser extent depending on the deficiency noted and the criteria set by the applicable DEQ program.

8.2 Program Implementation

Program data operations are implemented in accordance with an approved QAPP. Changes to the QAPP are documented and approved in writing through an amended QAPP. The QAPP may be revised as necessary and reissued within 30 days of significant changes. The latest approved version of the QAPP will remain in effect until a revised version has been approved.

The Program Managers oversee the program. Program Managers work in conjunction with the Program QA Officer to ensure that a project proceeds in the correct direction and generates the appropriate documentation.

8.3 SOP Implementation

All standardized procedures used for sampling, analytical, and data reporting techniques are documented in the program specific SOP. The SOP ensures standardization of a task for consistency in data generation across the regions. The Program QA Officer, who is familiar with the procedures being described, writes the program SOPs. A panel consisting of experienced program staff and managers from central and regional offices reviews the SOPs. The WD Directors approve final documents for their respective Offices.

Personnel who perform an activity or function use procedures covered by the appropriate SOP. It is the responsibility of the regional Program Managers to ensure program SOPs are properly implemented. It is the responsibility of the individual users to follow the procedures contained in the SOP or to document any deviations. The implementation of SOPs is assessed through internal field audits.

A list of the significant and applicable the VADEQ and DCLS SOPs is provided in Appendix A. SOP's not listed in the appendix are generally maintained by the Project Manager or QA Officer or available online through the Program's website. Most if not all of the VADEQ water monitoring related SOP's is stored on the CEDS database.

8.4 Implementation of the Analytical Methods Manual

DCLS analytical personnel use the analytical methods manual to document procedures. The group managers are responsible for ensuring that personnel utilize approved methods as specified in the analytical method manual. Implementation of the analytical methods manual procedures are ensured through blind performance evaluation samples and a NELAC accrediting entity. DCLS is a NELAC accredited laboratory and is compliant with the NELAC Institute (TNI) 2009 Standards.

Under Virginia Administrative Code § 2.2-1105, in 2010 Virginia implemented a NELAC laboratory accreditation program for commercial laboratories and an "NELAC type" certification program with DCLS as the accrediting authority for the Commonwealth. The DCLS Laboratory Certification team will regularly conduct compliance assessments of laboratories who submit water quality data to the VADEQ, as outlined in 1 VAC 30-45 and 1 VAC 30-46. This will ensure data submitted by such a laboratory meet DQOs for the applicable program that utilizes the data.

9.0 ASSESSMENT AND RESPONSE

This section of the QMP describes how the VADEQ will assess the effectiveness of its quality management system by using a variety of technical reviews, performance evaluations, and QA audits to make sure that the procedures in this QMP are implemented successfully.

9.1 Review of the VADEQ Quality Assurance Program

The Program QA Officers conduct internal assessments of their respective QA program at least every two years. The evaluations are submitted to the regional Program Managers in a written memo. The reviews are intended to accomplish the following objectives:

1) Identify any data quality problems.

2) Propose recommendations for resolving quality problems and confirm implementation and effectiveness of any recommended corrective actions.

Assessment personnel are knowledgeable in all areas of water quality monitoring and independent from regional monitoring personnel to avoid a conflict of interest. Assessment personnel attend training seminars, workshops, and forums to maintain assessment proficiency. Assessment personnel will have access to all Program Managers, records, and documents pertaining to water quality monitoring. Assessment personnel have the authority to modify the database for QA purposes.

All assessment summaries are given to the regional Program Managers for their review. The regional Program Managers will prepare a written response to the reviewer's memo. If the Program QA Officer recommends corrective actions, the regional Program Managers should address those recommendations within 30 days and include a schedule for making any appropriate changes in its quality assurance procedures. Once the corrective actions are implemented, the Program QA Officer will document the effectiveness of the corrective actions, either requesting further action or indicating that the problem has been resolved.

If a regional Program Manager disagrees with the Program Quality Assurance Officer's findings and recommendations, a panel of regional monitoring personnel familiar with the issues can be assembled to resolve the issue. Should the panel be unable to conclude the issue, the WD Director from Central Office will be asked to arbitrate a resolution in relation to the affected VADEQ Office.

9.2 Technical Systems Audits (TSAs)

A TSA assesses the sampling and analytical quality control procedures used to generate environmental data. The Program QA Officer will use TSAs to evaluate the procedures used by field monitoring staff and laboratory contractors. TSAs may entail a comprehensive on-site evaluation of field equipment and laboratory instrument calibration; record keeping procedures; and data validation, data management, and reporting.

9.2.1 Laboratory TSAs

DCLS has instituted a separate group within the division that has been reorganized as a The NELAC Institute Accrediting Body to conduct TSAs or on-site assessments of environmental laboratories using procedures outlined by NELAC. DCLS is NELAC accredited through accreditation assessments performed by the state of New Jersey. DCLS will conduct TSAs or onsite assessments of compliance to regulations 1VAC 30-45 or 1 VAC 30-46, whichever is applicable, of non-exempt laboratories who submit analytical data to the VADEQ.

Citizen monitoring and related laboratories exempt from the DCLS VELAP inspection (1 VAC 30-45-30) and who submit water quality data to the VADEQ are inspected by the agency once every two years, or as needed. The primary goals of TSAs are to review the laboratory organization, operation, and capabilities and to determine the reliability of the data and note corrective action for any apparent deficiencies. The Program QA Officer is responsible for planning and conducting the audits and reporting the findings to laboratory managers and VADEQ Program Managers.

9.2.2 Field TSAs

Oversight of field operations is an important part of the QA process, and the Program QA Officer or designee conducts QA audits of field sample activities, both for its own field operations and for its contractors. Field TSAs are conducted for each regional office annually, and the findings reported to the regional Program Managers.

Field TSAs of citizen volunteer and similar non-VADEQ water monitoring groups are usually conducted once every two years or as needed. The frequency of inspection depends on a number of factors, such as the type and quantity of data being generated, new protocols that are used, systematic issues that are found with the provided data, or if the provided QAPP and SOP materials are found to be lacking in sufficient training oversight. When a field TSA is conducted, a VADEQ QA Officer or designated proficient staff member meets with the monitoring group to review their procedures. If issues are found, they are noted and shared with the organization's Project Manager or QA Officer so that corrective action can be taken. If the deficiency is significant and results in questionable data, the issue is reported to the Project Manger and QA Coordinator and the data submitted by the organization during the period is flagged and downgraded. If the issues are corrected and documented to be back in compliance, a follow-up field TSA is done, and if acceptable, subsequent data is not flagged and returns to the original data quality level.

9.2.3 TSAs of Other Submitted Data

Data provided by non-VADEQ organizations not related to specific water quality monitoring are evaluated by the Program QA Officer by conducting accuracy checks of the data provided. Checks are usually conducted one or more times a year and usually involve a random sampling of submitted results for review. If issues are found with the submitted information, the QA Officer brings the deficiencies to the attention of the data submitter and the Project Manager for

correction. If specific projects require different type of TSA review, these are outlined in the program QAPP and SOP documents.

9.2.3 Performance Evaluations

Performance evaluations are conducted to assess the ability of a laboratory or field measurement system to obtain reliable data. The evaluation consists of providing a reference or "blind" sample to the laboratory for analysis. The performance evaluation sample contains known concentrations of chemical constituents or pollutants of interest that are normally found in the appropriate media. The analytical results obtained by the laboratory are compared to the known concentrations of the specific parameters contained in the performance samples to determine if the laboratory properly identified and quantified pollutants within established or calculated control limits.

9.3 Data Quality Evaluations

9.3.1 Data Quality assessments

A Data Quality assessment (DQA) is a statistical process used to determine whether the quality of a given data set is adequate for its intended use. The Program QA Officers routinely review and validate data generated by DCLS and other contracted laboratories. These data validation activities use checklists, standard operating procedures, and standardized qualification codes to determine data quality. The use of checklists and SOPs helps standardize the data validation process and minimizes any discrepancy that may result between data validators within the VADEQ and DCLS laboratory personnel. The data quality assessment SOP and checklist are listed in Appendix B.

Projects not involving laboratory analysis will have different DQA requirements and checks. As such, specific requirements and checks are outlined in the project QAPP and SOP document.

9.3.2 Data Completeness

A data quality audit assessment primarily involves a completeness check of the generation of field and analytical data. The VADEQ Oracle database automatically checks field and laboratory results data entry for parameter completeness. Incomplete field data is allowed into the database because instrument failures can occur, resulting in missing field parameters. The database generates an error report that is then reviewed by Central Office personnel. Incomplete analytical results are also allowed into the database, as analytical results are batch uploaded. The QA Coordinator or a designated staff member will serve as a Laboratory Liaison who is responsible for reviewing the report for the missing analytical results and for contacting either OIS to determine the cause of the problem or DCLS for data corrections.

Data completeness assessments for non-analytical datasets follow a similar protocol as stated above. Either the database used performs similar automatic checks to inform the data user of gaps or a VADEQ staff member or Program QA Officer reviews the datasets on a regular basis and identifies gaps or other inconsistencies in the dataset. When issues are found, they are

reported to the Project Manager or directly to the data submitter in an attempt to correct the issue. Specific details on how this is accomplished are provided in the relevant QAPP and SOP manual.

10.0 QUALITY IMPROVEMENT

The WD actively supports quality improvement by encouraging the VADEQ staff, laboratory staff, and data submitting organizations to meet the following goals:

1) Continually evaluate the effectiveness of current procedures and practices.

2) Apply innovative approaches to maintaining integrity and accuracy.

The above goals can be achieved by committing resources to the quality management system to enable the constant evaluation of data collection and individual staff performance. The quality management system is designed to identify opportunities for improving the measurement process. Improvement can take the form of preventing quality problems from occurring by adjusting current work processes or seeking out better ways to do the work. The goal is to prevent quality problems from occurring or recurring. Every attempt is made to ensure QA problems are identified and resolved quickly by encouraging open communication between field personnel and Central Office personnel as well as between laboratory personnel and associated QA officers.

The Program QA Officers are responsible for coordinating and evaluating water quality monitoring Program Quality improvement activities.

The Program QA Officers and regional Program Managers annually review all the QA activities of the project and staff; this includes reviewing SOPs for adequacy and revising them if necessary. All deviations and discrepancies noted during the assessment review are corrected promptly and affected data is flagged.

APPENDIX

Appendix A: List of significant VADEQ and DCLS SOP and their locations

SOP title	Location
VADEQ Ambient Water Quality Monitoring QAPP	Central database, CEDS
VADEQ Water Quality Monitoring SOP	Central database, CEDS
QAPP for the VA River Input Monitoring Program	www.chesapeakebay.net
QAPP for Chesapeake bay mainstem and Elizabeth River Water Quality Monitoring Program	www.chesapeakebay.net
VA Tributary Monitoring Program QAPP	www.chesapeakebay.net
VA CBP Non-tidal Network Monitoring Program QAPP	www.chesapeakebay.net
Accelerated Solvent Extraction	DCLS building , room 368
Acidity in water	DCLS building , room 327
Alkalinity in water	DCLS building , room 327
Anions- Ion Chromatography	DCLS building , room 327
Biochemical Oxygen Demand	DCLS building , room 327
Cations – Ion Chromatograph	DCLS building , room 327
Chemical Oxygen Demand	DCLS building , room 327
Chlorophyll	DCLS building , room 327
Clean Metals Kits and Assembling Procedure	DCLS building , room 357A
Cleaning Procedure for Metals Glassware	DCLS building , room 357A
Color	DCLS building , room 327
Determination of Metals in High Volume Air Filters (EPA IO-3.1/3.5	DCLS building , room 357A
Determination of Particulate Matter in Ambient Air	DCLS building , room 357A
Determination of Trace Metals in Ambient Water by ICP-MS	DCLS building , room 357A
Determination of Trace Metals in Fish Tissue by ICP-MS	DCLS building , room 357A
Determination of Trace Metals in Sediment by ICP/MS	DCLS building , room 357A
Determination of Trace Metals in Water and Aqueous Extracts by ICP-AES	DCLS building , room 357A
Determination of Trace Metals in Water by ICP/MS	DCLS building , room 357A
Digestion of Drinking Water and Waste Waters	DCLS building , room 357A
E. Coli by Colilert QuantiTray MPN	DCLS building , room 231
Enterococci by Membrane Filtration	DCLS building , room 231
Extractable Organic in Soils	DCLS building , room 368
Fecal Coliform by Membrane Filtration	DCLS building , room 231
Gel Permeation Chromatography Cleanup	DCLS building , room 368
Lead in Air by ICP-MS (EPA R9 FEM Pb July 2010)	DCLS building , room 357A
Mercury by Cold Vapor Flameless AA	DCLS building , room 357A
Mercury in Water by Cold Vapor Atomic Fluorescence Spectroscopy	DCLS building , room 357A
Microwave Assisted Acid Digestion of Tissues	DCLS building , room 357A
Nitrogen - Ammonia	DCLS building , room 327
Nitrogen - Nitrite and Nitrate	DCLS building , room 327
Nitrogen – Total Kjeldahl	DCLS building , room 327
Oil and Grease	DCLS building , room 327

SOP title	Location
Organochlorine Pesticides by GC/MS	DCLS building , room 368
Organophosphorus Pesticides by GC/MS	DCLS building , room 368
Particle size	DCLS building , room 327
Particulate Inorganic Carbon	DCLS building , room 327
Particulate Inorganic Phosphorus	DCLS building , room 327
Particulate Nitrogen/Carbon	DCLS building , room 327
Particulate Phosphorus	DCLS building , room 327
PH	DCLS building , room 327
Preparation of Sediments, Sludges, and Oils by Microwave Assisted Acid Digestion	DCLS building , room 357A
Sediment TOC	DCLS building , room 327
Semi-Volatile Organics by GC/MS	DCLS building , room 368
Settleable Solids	DCLS building , room 327
Silica	DCLS building , room 327
Sulfide	DCLS building , room 327
Surfactants (MBAS)	DCLS building , room 327
Suspended Sediment	DCLS building , room 327
Tannin and Lignin	DCLS building , room 327
Total Cyanide	DCLS building , room 327
Total Dissolved Solids	DCLS building , room 327
Total Hardness	DCLS building , room 327
Total Nitrogen	DCLS building , room 327
Total Organic Carbon	DCLS building , room 327
Total Phenols	DCLS building , room 327
Total Phosphorus	DCLS building , room 327
Total Solids	DCLS building , room 327
Total Suspended Solids	DCLS building , room 327
Turbidity	DCLS building , room 327
Turbidity Screening and Preservation Check for Water Samples (EPA Method 180.1)	DCLS building , room 357A

Appendix B Water Quality Data Quality Assessment SOP and Checklist

Note: The below SOP and checklist was developed to manage water quality data collected, analyzed, and submitted to VADEQ, which composes the majority of data received and used by the agency under this QMP. For non-monitoring related projects, a similar checklist document would be part of the appropriate Project SOP or QAPP.

Any time data are generated, their quality must be assessed prior to use. The type and degree of assessment required depends upon the project DQOs. Several different levels of data assessment exist, including data verification, data qualification/review, data evaluation, and data validation.

Data Verification: Data verification is confirmation by examination and provision of objective evidence that specified requirements have been fulfilled. Data verification is the process of evaluating the completeness, correctness, and conformance/compliance of a specific dataset with respect to the methodological, procedural, or contractual requirements.

Data Review: Data review is the next step in the data assessment hierarchy. Data review is the process of data assessment performed to produce the QA reports. Data review includes an assessment of summary QC data provided by the laboratory. Data review includes examination of primary and QA laboratory data and internal QC and QA sample results to ascertain the effects on the primary laboratory's data. Table 1 shows more detail on the specifics of data review. Data review documents possible effects on the data that result from various QC failures. It does not determine data usability nor does it include assignment of data qualification.

1) The initial inspection of the data is for errors and inconsistencies. Such checks include personnel checking chain of custody forms, sample-handling procedures, analyses requested, sample holding times met, proper preservation of samples was followed, and sample ID. Personnel verify that the data was checked by the Laboratory or Project Manager or QA Officer.

2) The next phase of data quality review is examination of the actual data. Such checks include examining data from laboratory matrix duplicates, blind duplicates, trip blanks, equipment blanks, laboratory method blanks, laboratory control samples, Matrix Spike (MS) samples, Matrix Spike Duplicate (MSD) samples, and surrogate and internal standard recoveries. Laboratory personnel make the determination if the data are of acceptable quality.

3) For laboratory-based data, the laboratory should provide initial calibration and continuing calibration checks to the data user. The laboratory performs a continuing calibration check standard daily to verify the calibration curve. One or more compounds may fail the continuing calibration check standards, but if the majority of compounds are within allowable limits, the calibration is considered good. The compounds that fail the continuing calibration check standards are flagged accordingly, and their results considered to be estimated.

4) For laboratory-based data, both laboratory control samples (LCSs) and matrix duplicates are examined during data review. The precision of the data is quantified by the Relative Percent

Difference (RPD) between two results obtained for the sample. The sample may be either internal laboratory QC samples or field samples. A high RPD in an LCS/LCSD pair is an indication of overall method failure and may result in the rejection of the entire dataset. MS and MSD samples are also assessed by their RPD values. High RPD values indicate a lack of reproducibility, and such data may be qualified or rejected. Any such results should be noted in the assessment of data quality.

5) Data from blank samples are examined to determine if sample contamination occurred either during or after sample collection. Equipment or rinsate blanks consist of regent water pass through or over sampling equipment following sample collection and sample equipment decontamination. Contaminated equipment blanks indicate inadequate decontamination between samples and a strong likelihood of cross contamination between samples. Method blanks are blank samples prepared in the laboratory and analyzed along with project samples. If analytes are detected in a method blank, this is a strong indication of laboratory contamination. This would increase the possibility that project sample aliquots were contaminated in the laboratory as well. Trip blanks are samples of pure water that accompany the project samples from the field to the lab. Trip blanks accompany each shipment of water samples to be analyzed for volatile organic compounds. Analyses of trip blanks indicate whether sample contamination occurred during shipment and/or storage.

6) Surrogate recoveries are scrutinized to ensure they fall within an acceptable range. Adequate surrogate recoveries in QC samples indicate that sample extraction procedures were effective and that overall instrument procedures were acceptable. Surrogate recoveries in field samples are a measurement of possible matrix effects and can indicate complete digestion or extraction of a sample. Surrogate recoveries outside control limits may result in qualified or rejected data.

7) An LCS is an aliquot of a clean matrix (i.e. clean water or sand) which contains a known quality of an analyte. Good recoveries from an LCS indicate that analytical methods are in control and that the laboratory is capable of generating acceptable data. The evaluation of possible matrix effects and accuracy of the data are monitored by analysis of MS and MSD of samples. An MS sample is prepared by adding a known quality of an analyte to a field sample. An MSD sample is prepared in an identical manner. MS/MSD should be analyzed at least once per every twenty five samples, or once per preparation batch, whichever is greater. Recovery of the MS indicates the matrix effects and is another measure of data accuracy. Comparison of the MS/MSD results provides an indication of data precision. All MS/MSD data should be examined. Low or high spike recoveries are evidence of matrix effects and poor accuracy; a high RPD for duplicates is evidence of low precision. All such results should be reported in the data review.

8) Analysis of blind duplicate QC samples provides a measure of sample homogeneity and intra-laboratory variations. An additional replicate sample is provided to an independent QA laboratory to provide a further test of sample homogeneity and a test of inter-laboratory accuracy.

Data Evaluation: Data evaluation follows data review. During data evaluation, the QA Officer uses the results of the data review as summarized in the QA report to determine the usability of the data. The QA report documents the potential effects of QA/QC failures on the data, and the Project Manager assesses their impact on attainment of DQOs.

Data Qualification: Data assessment will result in documentation of the quality and usability of the data. Data qualification is the process of flagging analytical data (both detects and non-detects) according to a set of pre-established functional guidelines to reflect any QC failures. The procedure includes flagging each sample to reflect any failures for the sample itself (e.g. extended holding time) and any failure of a QC sample referenced to the sample (e.g. blank contamination). Normally, the procedures used are those found in the USEPA Contract Laboratory Program National Functional Guidelines for Organic data Review and Inorganic data Review.

Table 1 Data Validation Element

QC element	Type of failure	Possible cause	Possible effect on data
Instrument calibration records	No accurate record of instrument calibration	Missing	Incomplete data
Chain of Custody	Chain broken or not kept	Missing signatures, missing seals, missing date/times	Incomplete data
Sample labeling	Sample container labels unreadable, missing or not attached	Failure to protect from moisture, failure to use appropriate labels, failure to label samples	Invalidation of affected sample results
	Sample mislabeled	Sampler error	Invalidation of all sample results collected on sample run
Sample containers	Wrong containers used for sample	Samplers unaware of requirements	False positives, false negatives, high or low bias, matrix interference
Preservation	No preservatives or wrong pH	No preservatives added or improper amount/strength of preservative added	False negatives, low bias
	Too warm (>4^{o}C)	Insufficient ice, shipping container inadequately insulated, samples not pre-chilled prior to shipping, transit time too long	False negatives, high or low bias
Holding time	Holding times exceeded	Excessive analysis time, tardy ship date, inappropriate shipping method	False negatives, high or low bias
Detection limit (DL)	DL too high	Insufficient measures to combat interference, insufficient sample, high dilution factor, wrong or inappropriate method	False negatives, low sensitivity
Equipment blank	Contamination > DL	Improper decontamination of field sampling equipment., contaminated rinsate water, containers, or preservatives	False positives, high bias
Trip blank	Contamination > DL	Cross contamination during sample shipping or storage, contaminated reagent water, glassware, or preservatives	False positives, high bias
Method blank (MB)	Contamination > DL	Contaminated reagents, gases, glassware, ambient contamination, poor laboratory technique	False positives, high bias
Field QC sample	Field and QC sample concentrations do not compare within acceptable limits	Sample inhomogeneity, insufficient mixing in the field or lab, sample was not split but collocated.	Non-representative sample, poor precision (high or low bias)
	QA sample results do not agree with project and/or QC sample results	Improper SOP, inadequate cleanup, inadequate background correction, contamination, preservative problem, sample misidentification, method failure, sample inhomogeneity , etc.	Various
Surrogate in samples	Low recoveries	Matrix effects, inappropriate method, method failure, improper spiking, degraded spiking solution, failed spiking device.	False negatives, low bias
	High recoveries	Matrix effects, inappropriate method, method failure, improper spiking, degraded spiking solution, failed spiking device, contaminated reagents, glassware etc.	High bias, false positives

QC element	**Type of failure**	**Possible cause**	**Possible effect on data**
Laboratory control sample / duplicate (LCS/ LCSD)	Low recoveries	Method failure, improper spiking, degraded spiking solution, failed spiking device	False negatives, low bias
	High recoveries	Method failure, improper spiking, degraded spiking solution, failed spiking device, contaminated reagents, glassware etc.	High bias, possible false positives
	High RPDs	Method failure, improper spiking, failed spiking device, contaminated reagents, glassware etc.	Poor precision (high variability)
Surrogates in MB,LCS and LCSD	Low recoveries	Method failure, improper spiking, degraded spiking solution, failed spiking device	False negatives, low bias
	High recoveries	Method failure, improper spiking, degraded spiking solution, failed spiking device, contaminated reagents, glassware etc.	High bias, possible false positives
Matrix spike / duplicate (MS/MSD)	Low recoveries	Matrix effects, inappropriate method, method failure, inadequate cleanup, inadequate background correction, fail to use method of standard additions, improper spiking, and degraded spiking solution, failed spiking device.	False negatives, low bias
	High recoveries	Matrix effects, inappropriate method, method failure, inadequate cleanup, inadequate background correction, fail to use method of standard additions, improper spiking, and degraded spiking solution, failed spiking device, contaminated reagents, glassware etc.	High bias, false positives
	High RPDs	Sample inhomogeneity, inadequate sample mixing in the lab, sample misidentified, method failure, improper spiking, and degraded spiking solution, failed spiking device, contaminated reagents, glassware etc.	Non-representative sample, poor precision (high variability)